
SR 87/SR 260/SR 377 CORRIDOR PROFILE STUDY

JUNCTION SR 202L TO JUNCTION I-40

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DRAFT WORKING PAPER 5: STRATEGIC SOLUTIONS

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

1.1 Corridor Study Purpose2

1.2 Corridor Study Goals and Objectives2

1.3 Working Paper 5 Overview2

1.4 Corridor Overview2

1.5 Study Location and Corridor Segments.....2

2.0 SUMMARY OF CORRIDOR NEEDS 5

2.1 Summary of Needs.....5

2.2 Strategic Investment Areas7

3.0 STRATEGIC INVESTMENT AREA SCREENING 10

4.0 CANDIDATE SOLUTIONS 15

4.1 Characteristics of Strategic Solutions.....15

4.2 Strategic Solution Types.....15

4.3 Candidate Solutions15

4.4 Other Corridor Solutions.....19

4.5 Policies and Initiatives19

5.0 NEXT STEPS 20

LIST OF TABLES

Table 1: SR 87/SR 260/SR 377 Corridor Segments3

Table 2: Strategic Investment Level Screening11

Table 3: Candidate Solutions16

LIST OF FIGURES

Figure 1: Study Area1

Figure 2: Corridor Location and Segments.....4

Figure 3: Corridor Needs Summary.....8

Figure 4: Strategic Investment Areas9

Figure 5: Candidate Solutions18

Figure 6: Candidate Solution Evaluation Process20

APPENDICES

Appendix A: Solution Types

LIST OF ABBREVIATIONS

ABBREVIATION	NAME
ADOT	Arizona Department of Transportation
CAG	Central Arizona Governments
CCTV	Closed Circuit Television
CPS	Corridor Profile Study
DMS	Dynamic Message Sign
EB	Eastbound
FY	Fiscal Year
I	Interstate
ITS	Intelligent Transportation System
MAG	Maricopa Association of Governments
MP	Milepost
MPD	Multimodal Planning Division
NACOG	Northern Arizona Council of Governments
NB	Northbound
P2P	Planning to Programming
PTI	Planning Time Index
RWIS	Road Weather Information System
SB	Southbound
SHSP	Strategic Highway Safety Plan
SR	State Route
SRPMIC	Salt River Pima-Maricopa Indian Community
TPTI	Truck Planning Time Index
TTI	Travel Time Index
V/C	Volume/Capacity Ratio
WB	Westbound
WIM	Weigh-in-Motion

1.0 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of State Route 87 (SR 87)/State Route 260 (SR 260)/State Route 377 (SR 377) between State Route 202L (Loop 202) and Interstate 40 (I-40). This study will look at key performance measures relative to the SR 87/SR 260/SR 377 corridor, and the results of this performance evaluation will be used to identify potential strategic improvements.

The intent of the corridor profile program, and of the Planning to Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network. ADOT is conducting eleven CPS. The eleven corridors are being evaluated within three separate groupings.

The first three studies (Round 1) began in spring 2014, and encompass:

- I-17: SR 101L to I-40
- I-19: Mexico International Border to I-10
- I-40: California State Line to I-17

The second round (Round 2) of studies, initiated in spring 2015, includes:

- I-8: California State Line to I-10
- I-40: I-17 to the New Mexico State Line
- SR 95: I-8 to I-40

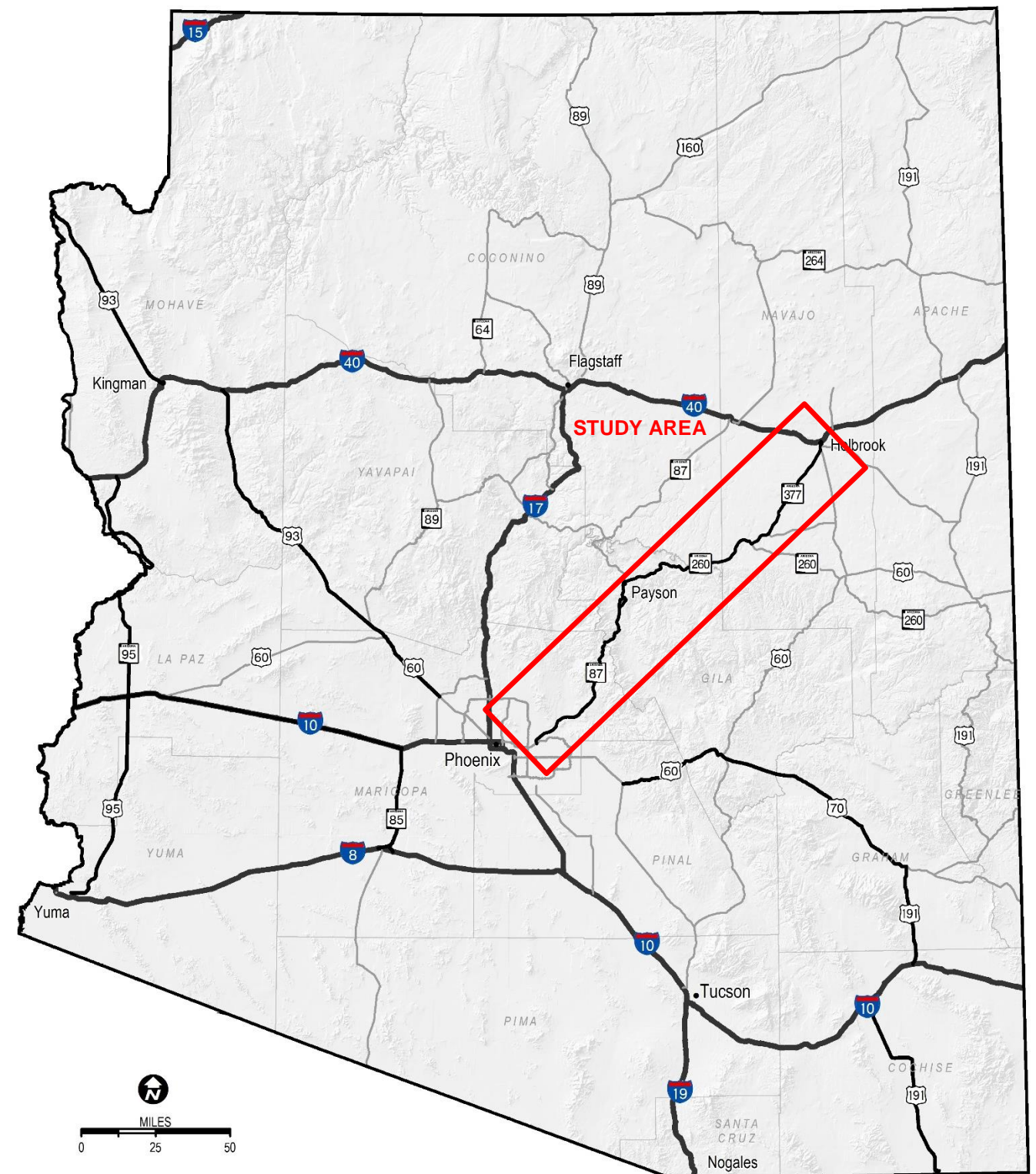
The third round (Round 3) of studies, initiated in fall 2015, includes:

- I-10: California State Line to SR 85 and SR 85: I-10 to I-8
- I-10: SR 202L to the New Mexico State Line
- SR 87/SR 260/SR 377: SR 202L to I-40
- US 60/US 70: SR 79 to US 191 and US 191: US 70 to SR 80
- US 93/US 60: Nevada State Line to SR 303L

The studies under this program will assess the overall health, or performance, of the state's strategic highways. The Corridor Profile Studies will identify candidate projects for consideration in the Multimodal Planning Division's (MPD) P2P project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

SR 87/SR 260/SR 377, Loop 202 to I-40, depicted in **Figure 1**, is one of the strategic statewide corridors identified and is the subject of this Round 3 CPS.

Figure 1: Study Area



1.1 Corridor Study Purpose

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process established by the previous Round 1 and Round 2 corridor profile studies to:

- Inventory past improvement recommendations.
- Define corridor goals and objectives.
- Assess existing performance based on quantifiable performance measures.
- Propose various solutions to improve corridor performance.
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures.
- Prioritize solutions for future implementation.

1.2 Corridor Study Goals and Objectives

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The SR 87/SR 260/SR 377 CPS will define solutions and improvements for the corridor that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance. Corridor benefits will be categorized by the following three investment types:

- **Preservation:** Activities that protect transportation infrastructure by sustaining asset condition or extending asset service life.
- **Modernization:** Highway improvements that upgrade efficiency, functionality, and safety without adding capacity.
- **Expansion:** Improvements that add transportation capacity through the addition of new facilities and/or services.

The following goals have been identified as the desired outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals.
- Develop solutions that address identified corridor needs based on measured performance.
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure.

1.3 Working Paper 5 Overview

The objective of Working Paper 5 is to document the development of strategic solutions derived from a performance-based needs assessment of the SR 87/SR 260/SR 377 corridor. Corridor needs were defined in Working Paper 4 through a review of the difference between baseline performance (Working Paper 2) and desired performance (Working Paper 3).

1.4 Corridor Overview

The SR 87/SR 260/SR 377 corridor between Loop 202 and I-40 provides movement for freight, tourism, and recreation needs within Arizona. It provides a key link between the Phoenix

metropolitan area and the northeast region of the state and serves intrastate, interstate, and international commerce. The corridor connects Mesa, Fountain Hills, Payson, Heber-Overgaard and Holbrook as well as the Salt River Pima Maricopa Indian Community (SRPMIC), Fort McDowell-Yavapai, and Tonto Apache tribes. This corridor also serves a number of recreational areas and National Forests. The SR 87/SR 260/SR 377 corridor includes portions of SR 87, SR 260, SR 277, SR 377, SR 77, and I-40 Business Route (40B)

1.5 Study Location and Corridor Segments

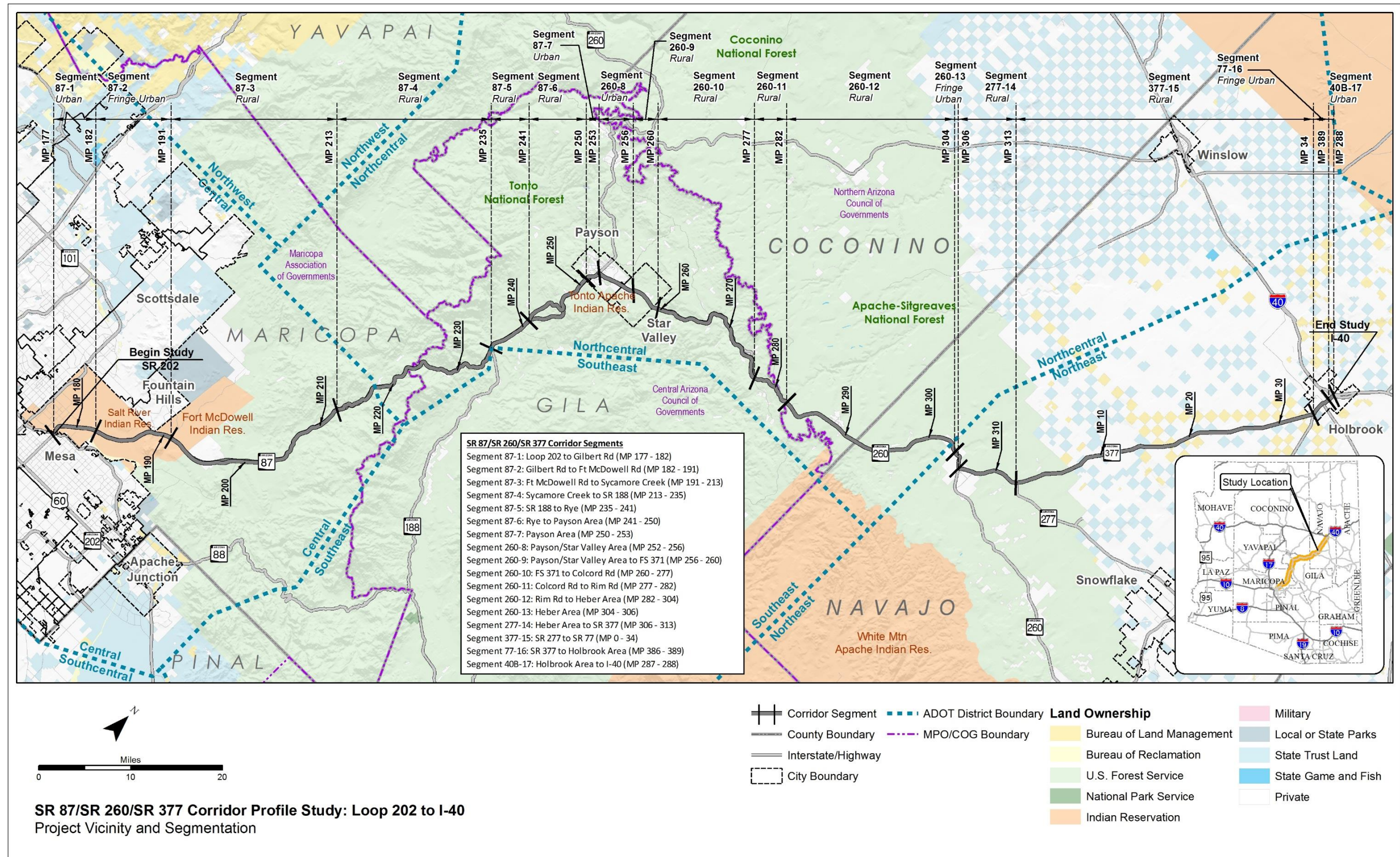
The SR 87/SR 260/SR 377 corridor between Loop 202 and I-40 is approximately 175 miles in length. The SR 87/SR 260/SR 377 corridor is located in three ADOT Districts (Central, Northcentral, and Northeast); three planning areas (Maricopa Association of Governments [MAG], Central Arizona Governments [CAG], and Northern Arizona Council of Governments [NACOG]); and four counties (Maricopa, Gila, Coconino, and Navajo).

The SR 87/SR 260/SR 377 study corridor has been divided into 17 segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. These segments are described in **Table 1** and shown in **Figure 2**.

Table 1: SR 87/SR 260/SR 377 Corridor Segments

Segment	Route	Begin	End	Approximate Begin Milepost	Approximate End Milepost	Approximate Length (miles)	Typical Through Lanes (NB/EB, SB/WB)	2014 Average Annual Daily Traffic Volume (vpd)	Character Description
87-1	SR 87	Loop 202	Gilbert Rd	177	182	5	2,2	15,000 – 16,000	This segment has interrupted flow, numerous access points, consistent traffic volumes, a five-lane undivided or four-lane divided section, and is located in the Phoenix metropolitan urban area.
87-2	SR 87	Gilbert Rd	Fort McDowell Rd	182	191	9	2,2	15,000 – 16,000	This segment has interrupted flow characteristics, access points, consistent traffic volumes, a four-lane divided section, and is located in the fringes of the Phoenix metropolitan urban area.
87-3	SR 87	Fort McDowell Rd	Sycamore Creek	191	213	22	2,2	9,000 – 10,000	This rural four-lane divided segment with uninterrupted flow has consistent topography and traffic volumes.
87-4	SR 87	Sycamore Creek	SR 188	213	235	22	2,2	10,000 – 11,000	This rural four-lane divided segment with uninterrupted flow has steep terrain and a curvy alignment.
87-5	SR 87	SR 188	Rye	235	241	6	2,2	11,000 – 12,000	This rural four-lane divided segment with uninterrupted flow has flatter terrain than surrounding segments.
87-6	SR 87	Rye	Green Valley Pkwy/BIA 101	241	250	9	2,2	11,000 – 12,000	This rural segment with uninterrupted flow is a climbing four-lane divided section.
87-7	SR 87	Green Valley Pkwy/BIA 101	SR 260	250	253	3	2,2	19,000 – 20,000	This segment has interrupted flow, numerous access points, is comprised of a five-lane undivided section and is located in the Payson urban area.
260-8	SR 260	SR 87	Mayfield Canyon Rd	252	256	4	2,2	14,000 – 15,000	This segment is comprised of a five-lane undivided section. It is located in the Payson/Star Valley urban area.
260-9	SR 260	Mayfield Canyon Rd	FS 371	256	260	4	1,1	13,000 – 14,000	This rural segment with uninterrupted flow is comprised of a two-lane undivided section.
260-10	SR 260	FS 371	Colcord Rd	260	277	17	2,2	6,000 – 7,000	This rural segment with uninterrupted flow is comprised of a four-lane divided section. It is a climbing section.
260-11	SR 260	Colcord Rd	Rim Rd	277	282	5	2,2	6,000 – 7,000	This rural segment with uninterrupted flow is comprised of a four-lane undivided section. It includes a climbing section to the top of Mogollon Rim.
260-12	SR 260	Rim Rd	Black Canyon Ln	282	304	22	1,1	5,000 – 6,000	This rural segment with uninterrupted flow is comprised of a two-lane undivided section.
260-13	SR 260	Black Canyon Ln	SR 277	304	306	2	2,2	7,000 – 8,000	This segment with uninterrupted flow is comprised of a five-lane undivided section. It is located in the fringes of the Heber-Overgaard urban area.
277-14	SR 277	SR 260	SR 377	306	313	7	1,1	1,000 – 2,000	This rural segment with uninterrupted flow is a two-lane undivided section.
377-15	SR 377	SR 277	SR 77	0	34	34	1,1	2,000 – 3,000	This rural segment with uninterrupted flow is a two-lane undivided section.
77-16	SR 77	SR 377	I-40 Business	386	389	3	1,1	7,000 – 8,000	This segment has interrupted flow, numerous access points, a two-lane or four-lane undivided section, and is located in the fringes of the Holbrook urban area.
40B-17	40B	SR 77	I-40/Navajo Blvd TI	287	288	1	2,2	10,000 – 11,000	This segment has interrupted flow, numerous access points, a four-lane or five-lane undivided section, and is located in the Holbrook urban area.

Figure 2: Corridor Location and Segments



2.0 SUMMARY OF CORRIDOR NEEDS

2.1 Summary of Needs

Working Paper 4 documented the performance-based needs assessment process and the results for the SR 87/SR 260/SR 377 corridor. The needs in each performance area were classified as either None, Low, Medium, or High based on a comparison of the corridor performance (Working Paper 2) to the performance objectives (Working Paper 3).

As documented in Working Paper 4, the needs for each segment were numerically combined to estimate the average level of need for each corridor segment. During the corridor study process for SR 87/SR 260/SR 377, the Mobility, Freight, and Safety performance areas were identified as emphasis areas. Therefore, during the calculation process a weighting factor of 1.50 was applied to the average need score in these performance areas. The table at the bottom of **Figure 3** shows the level of need for each segment by performance area, and the numeric average need for each segment.

Step 5 of the needs process translated the performance-based needs into corridor needs that are “actionable”. These needs can facilitate development of solution sets (projects, initiatives, countermeasures, and programs) to improve corridor performance through strategic investments in preserving, modernizing, and/or expanding the corridor. Corridor needs were developed through a segment-by-segment review of needs and contributing factors. This review also identified overlapping, common, and contrasting needs across performance areas.

The bullets below and referenced figure reflect the current needs analysis results for the SR 87/SR 260/SR 377 corridor and are the basis for the development of resulting candidate solutions of this working paper.

Pavement Needs

The Pavement Performance Area is not an emphasis area for the SR 87/SR 260/SR 377 corridor. One of the 17 segments of the SR 87/SR 260/SR 377 corridor exhibits a high level of need in Pavement Performance: Segment 277-14. Two segments exhibit a medium level of need and four segments exhibit a low level of need. Segments with need levels include the following (with the level of need in parentheses):

- Segment 87-1 Milepost (MP) 177-182 (low)
- Segment 87-3 MP 191-213 (low)
- Segment 87-4 MP 213-235 (low)
- Segment 260-13 MP 304-306 (medium)
- Segment 277-14 MP 306-313 (high)
- Segment 77-16 MP 386-389 (medium)
- Segment 40B-17 MP 287-288 (low)

Pavement hot spot failure needs are listed below:

- Segment 87-1 MP 177-178 Northbound (NB)
- Segment 87-3 MP 195-199 Southbound (SB)

- Segment 87-3 MP 200-201 SB
- Segment 87-4 MP 224-226 NB/SB
- Segment 260-13 MP 304-305 Eastbound (EB)
- Segment 277-14 MP 307-310 NB
- Segment 277-14 MP 311-313 NB
- Segment 77-16 MP 388-389 NB

Only one segment of the SR 87/SR 260/SR 377 corridor has a high level of historical investment: Segment 87-6. There are no programmed pavement rehabilitation projects on the corridor.

Bridge Needs

The Bridge Performance Area is not an emphasis area for the SR 87/SR 260/SR 377 corridor. One of the 17 segments of the SR 87/SR 260/SR 377 corridor exhibits a low level of need in Bridge Performance: Segment 77-16. No other segments exhibit bridge performance needs.

The identified need in Segment 77-16 is due to the Little Colorado River Bridge (structure number 2030) at MP 388, which has a low sufficiency rating and is functionally obsolete.

No bridges exhibit high levels of historical bridge maintenance investment for the SR 87/SR 260/SR 377 corridor. There are no programmed projects for existing bridges on the corridor.

Mobility Needs

The Mobility Performance Area is an emphasis area for SR 87/SR 260/SR 377. All 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Mobility Performance. There are two segments with high need levels. Segments with need levels include the following (with the level of need in parentheses):

- Segment 87-1 MP 177-182 (low)
- Segment 87-2 MP 182-191 (low)
- Segment 87-3 MP 191-213 (low)
- Segment 87-4 MP 213-235 (low)
- Segment 87-5 MP 235-241 (low)
- Segment 87-6 MP 241-250 (low)
- Segment 87-7 MP 250-253 (low)
- Segment 260-8 MP 252-256 (low)
- Segment 260-9 MP 256-260 (high)
- Segment 260-10 MP 260-277 (low)
- Segment 260-11 MP 277-282 (low)
- Segment 260-12 MP 282-304 (low)
- Segment 260-13 MP 304-306 (low)
- Segment 277-14 MP 306-313 (low)
- Segment 377-15 MP 0-34 (low)
- Segment 77-16 MP 386-389 (high)
- Segment 40B-17 MP 287-288 (low)

The percentage of closures on the SR 87/SR 260/SR 377 corridor due to incidents/accidents, obstructions/hazards, or weather is above the statewide average for the following segments:

- Segment 87-1 MP 177-182 (incidents/accidents)
- Segment 87-2 MP 182-191 (obstructions/hazards)
- Segment 87-3 MP 191-213 (obstructions/hazards)
- Segment 87-4 MP 213-235 (obstructions/hazards)
- Segment 87-5 MP 235-241 (obstructions/hazards)
- Segment 87-6 MP 241-250 (weather related)
- Segment 87-7 MP 250-253 (weather related)
- Segment 260-8 MP 252-256 (incidents/accidents)
- Segment 260-9 MP 256-260 (weather related)
- Segment 260-10 MP 260-277 (obstructions/hazards and weather related)
- Segment 260-11 MP 277-282 (weather related)
- Segment 260-12 MP 282-304 (weather related)
- Segment 260-13 MP 304-306 (weather related)
- Segment 277-14 MP 306-313 (obstructions/hazards)
- Segment 377-15 MP 0-34 (incidents/accidents)

A high Planning Time Index (PTI) need indicates a low degree of trip reliability. This could be due in part to the aforementioned closures, operational constraints like an at-grade railroad crossing, lack of climbing/passing lanes, and slow traffic due to steep grade. The following segments have a high directional PTI:

- NB/EB Segments 87-3, 87-4, 87-6, 260-8, 260-9, 260-10, 260-11, 260-13, and 40B-17
- SB/WB Segments 87-5, 87-6, 87-7, 260-13, 77-16, and 40B-17

Programmed projects include reconstructing horizontal curves and widening shoulders to eight feet in both directions on SR 377 (Segment 377-15) at MP 3.17-3.42, 5.04-5.20, 7.40-7.60, 13.33-13.61, 14.97-15.12, 17.69-18.56, 18.64-18.91, 20.87-21.29, 27.99-28.22, 33.68-33.82 in Fiscal Year (FY) 2018. Also, reconstruction of SR 260 (Segment 260-9), MP 258-260 to a 4-lane divided highway facility is programmed for design in FY 2021 with tentative construction in FY 2024.

Safety Needs

The Safety Performance Area is an emphasis area for SR 87/SR 260/SR 377. Ten of 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Safety Performance while the other seven segments do not have an identified level of need due to insufficient data. Seven segments have either a medium or high level of need. Likely contributing factors are listed below for those segments with a medium or high level of need that have a large enough sample size to identify potential contributing factors.

- Segment 87-1 MP 177-182
 - Roadway departure
 - Driver inattention/distraction
 - Inadequate barrier between pedestrian and vehicle facilities
 - Shoulder/rumble strip condition
 - Inadequate lighting
 - Lack of crossing opportunity
 - Driving under the influence

- Segment 87-3 MP 191-213
 - Speed too fast for conditions
 - Driver inattention/distraction
 - Roadway departure
 - Pavement surface condition
 - Improper lane changes
 - Shoulder/rumble strip condition
 - Clear zone slopes and obstructions
 - Slippery/wet pavement surface
- Segment 87-4 MP 213-235
 - Speed too fast for conditions
 - Driver inattention/distraction
 - Roadway departure
 - Pavement surface condition
 - Shoulder/rumble strip condition
 - Clear zone slopes and obstructions
 - Slippery/wet pavement surface
- Segment 87-6 MP 241-250
 - Speed too fast for conditions
 - Driver inattention/distraction
 - Roadway departure
 - Pavement surface condition
 - Shoulder/rumble strip condition
 - Clear zone slopes and obstructions
 - Slippery/wet pavement surface
 - Driving under the influence
- Segment 260-12 MP 282-304
 - Speed too fast for conditions
 - Driver inattention/distraction
 - Roadway departure
 - Inadequate roadway geometry
 - Pavement surface condition
 - Shoulder/rumble strip condition
 - Clear zone slopes and obstructions
 - Driving under the influence
- Segment 377-15 MP 0-34
 - Speed too fast for conditions
 - Driver inattention/distraction
 - Roadway departure
 - Pavement surface condition
 - Shoulder/rumble strip condition
 - Clear zone slopes and obstructions
 - Slippery/wet pavement surface

- Driving under the influence
- Lack of restraint usage

Safety hot spots are listed below:

- Segment 87-4 MP 213-215 NB
- Segment 87-6 MP 245-248 SB
- Segment 260-8 MP 252-253 EB

Programmed projects include reconstructing horizontal curves and widening shoulders to eight feet in both directions on SR 377 (Segment 377-15) at MP 3.17-3.42, 5.04-5.20, 7.40-7.60, 13.33-13.61, 14.97-15.12, 17.69-18.56, 18.64-18.91, 20.87-21.29, 27.99-28.22, 33.68-33.82 in Fiscal Year (FY) 2018. Also, reconstruction of SR 260 (Segment 260-9), MP 258-260 to a 4-lane divided highway facility is programmed for design in FY 2021 with tentative construction in FY 2024.

Freight Needs

The Freight Performance Area is an emphasis area for SR 87/SR 260/SR 377. Fifteen of 17 segments of the SR 87/SR 260/SR 377 corridor exhibit some level of need in Freight Performance while the other two segments do not have an identified level of need due to insufficient data. There are 12 segments with either a medium or high level of need.

The percentage of closures on the SR 87/SR 260/SR 377 corridor due to incidents/accidents, obstructions/hazards, or weather above the statewide average for the following segments:

- Segment 87-1 MP 177-182 (incidents/accidents)
- Segment 87-2 MP 182-191 (obstructions/hazards)
- Segment 87-3 MP 191-213 (obstructions/hazards)
- Segment 87-4 MP 213-235 (obstructions/hazards)
- Segment 87-5 MP 235-241 (obstructions/hazards)
- Segment 87-6 MP 241-250 (weather related)
- Segment 87-7 MP 250-253 (weather related)
- Segment 260-8 MP 252-256 (incidents/accidents)
- Segment 260-9 MP 256-260 (weather related)
- Segment 260-10 MP 260-277 (obstructions/hazards and weather related)
- Segment 260-11 MP 277-282 (weather related)
- Segment 260-12 MP 282-304 (weather related)
- Segment 260-13 MP 304-306 (weather related)
- Segment 277-14 MP 306-313 (obstructions/hazards)
- Segment 377-15 MP 0-34 (incidents/accidents)

A high Truck Planning Time Index (TPTI) indicates a low degree of trip reliability for trucks. This could be due in part to the aforementioned closures, operational constraints like an at-grade railroad crossing, lack of climbing/passing lanes, and slow traffic due to steep grades. The following segments have high directional TPTI:

- NB/EB segments: 87-4, 87-6, 260-8, 260-9, 260-10, 260-11, 260-13, and 40B-17
- SB/WB segments: 87-3, 87-4, 87-5, 87-6, 260-10, 260-12, 260-13, and 40B-17

No vertical bridge clearance issues were identified on the corridor.

2.2 Strategic Investment Areas

The principal objective of the corridor profile study is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need (Medium or High). Addressing areas of Medium or High need will have the greatest effect on the corridor performance and are the focus of the strategic solutions. Segments with Medium or High needs and specific locations of hot spots are considered candidates for strategic solutions. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The areas of the SR 87/SR 260/SR 377 corridor identified for potential strategic investments are shown in **Figure 4**.

Figure 3: Corridor Needs Summary

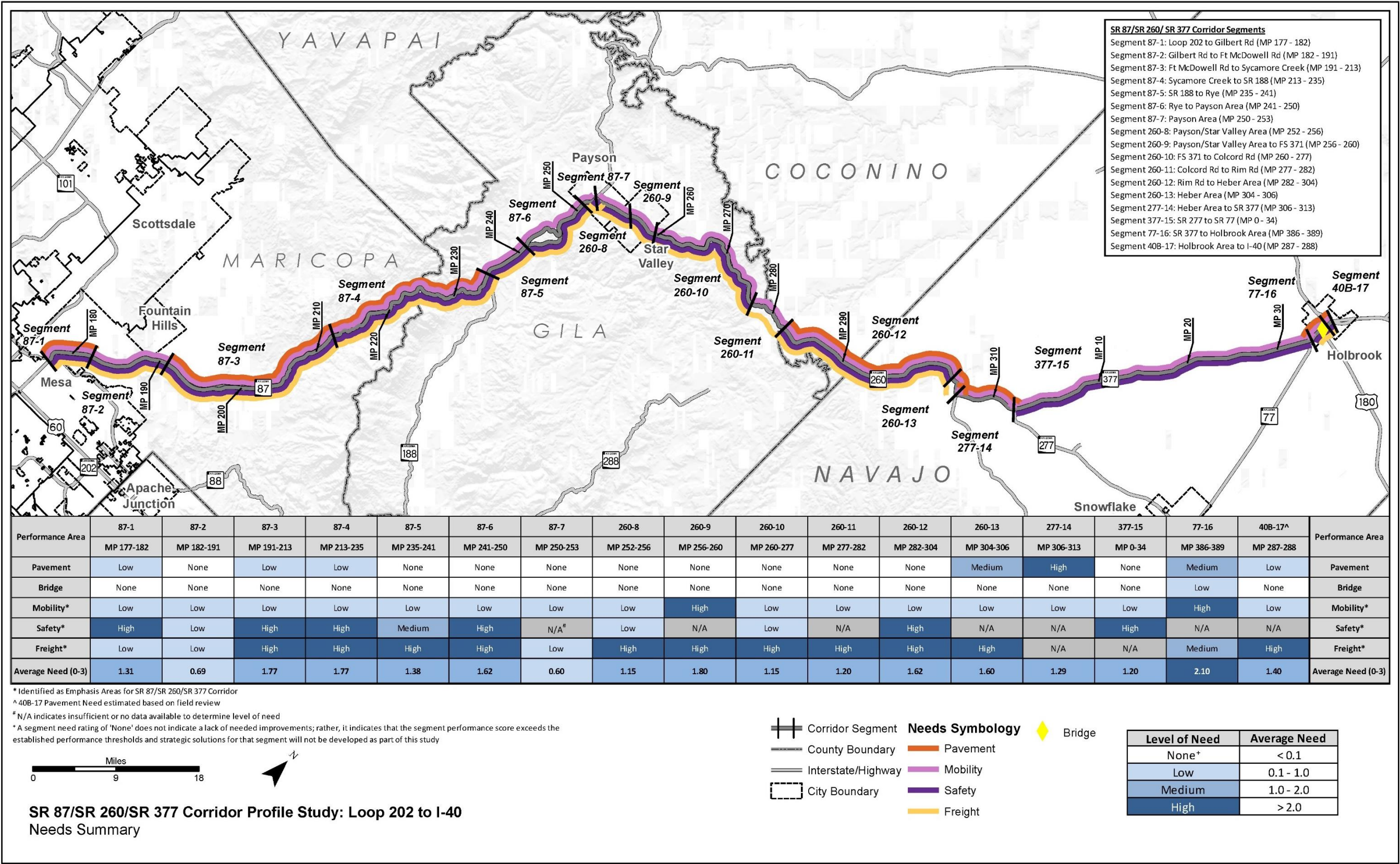
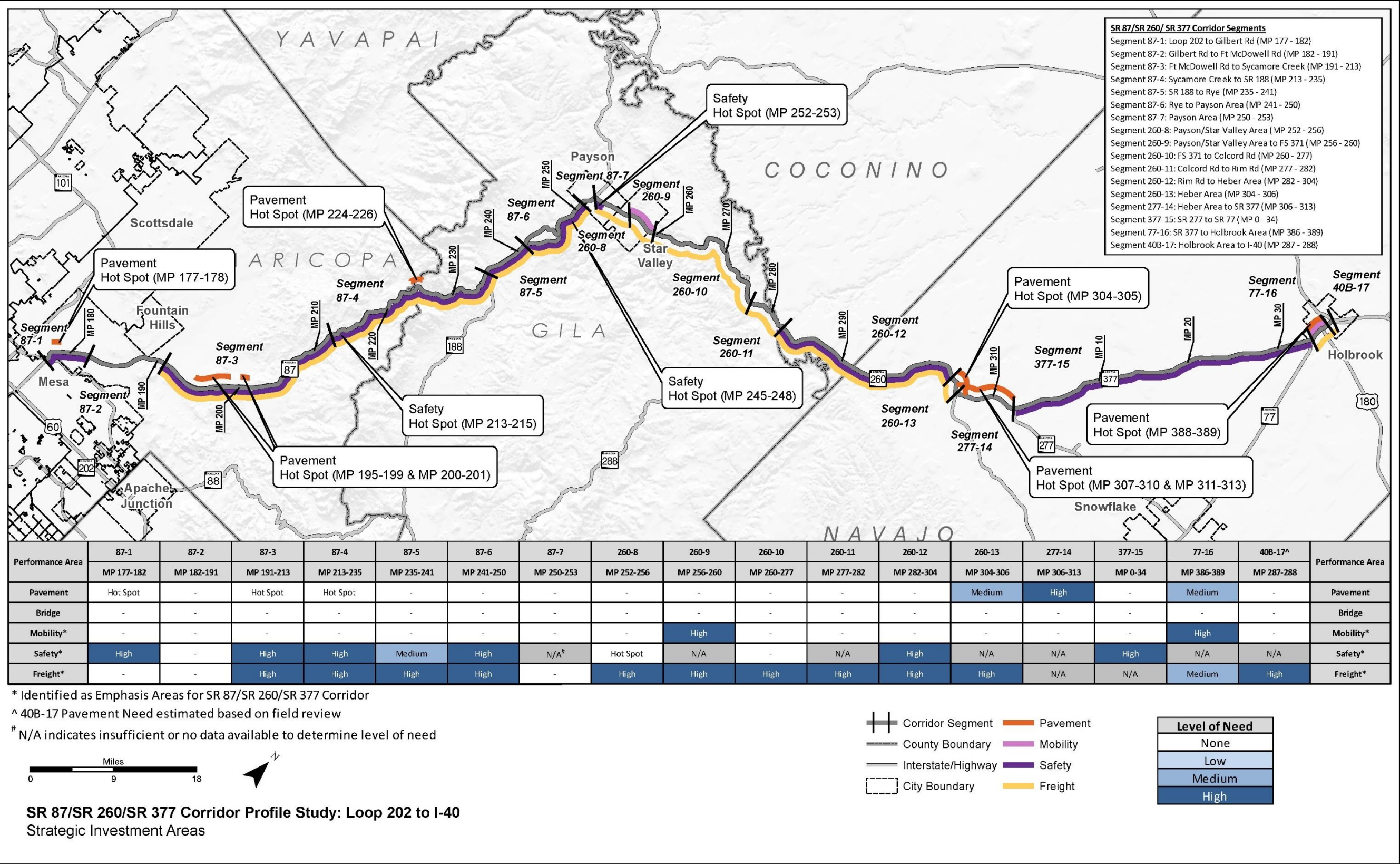


Figure 4: Strategic Investment Areas



3.0 STRATEGIC INVESTMENT AREA SCREENING

This section examines qualifying strategic needs and documents if the needs in those locations require action. **Table 2** notes if each potential strategic location will advance to solution set development, and if not, the reason for screening that location out of the solution development process. Locations advancing to solutions development are marked with Yes (Y); locations not advancing are marked with No (N) and highlighted.

In some cases, elevated needs do not advance to solution development and are screened out from further consideration because they have been or will be addressed through other measures, including:

- A project has already been programmed to address the need in the first three years of the current adopted five-year program.
- The need is a result of a pavement or bridge hot spot that does not show historical investment issues. These hot spots will likely be addressed through other ADOT programming means.
- A bridge is not a hot spot (a bridge hot spot exists where a given bridge has a bridge rating of 4 or lower or multiple ratings of 5) but is located within a segment with a Medium or High level of need. This bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes.
- The need is determined to be non-actionable (cannot be addressed through an ADOT project).
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need.

The remainder of the study focuses on developing appropriate solutions for the selected strategic locations. The screening table (**Table 2**) provides specific information about the needs in each segment considered for strategic investment. The table identifies the elevated needs - either Medium or High segment needs or segments without a Medium or High level of need that have a hot spot.

Each area of need has been assigned a Location Number to help document and track specific locations that are being considered for strategic investment throughout this process.

Table 2: Strategic Investment Level Screening

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance to Solution Development? (Y/N)	Reason for Screening Decision
	Pavement	Bridge	Mobility	Safety	Freight					
87-1 (MP 177-182)	Hot Spot			High		L1	Safety	MP 177-182 has a Safety Index significantly above the statewide average, particularly in the NB direction. Secondary performance scores are average or better. Crash data analysis indicates percent of crashes above statewide average related to collisions with pedestrians and fixed objects, 29% failure to yield, 58% in dark conditions, and 29% under the influence. 6 fatal crashes.	Y	No programmed project to address safety need
						L2	Pavement	Hot Spot NB at MP 177-178	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
87-2 (MP 182-191)						No Strategic Needs Identified				
87-3 (MP 191-213)	Hot Spot			High	High	L3	Safety	MP 191-213, high level of need in the SB direction, motorcycle crashes. Crash data analysis indicates percent of crashes above statewide average related to overturning and other non-collision crashes, 72% involve single vehicle, 50% run off road (left or right), and 11% sideswipe in same direction. 7 fatal crashes and 7 involving motorcycles.	Y	No programmed project to address safety need
						L4	Freight	MP 191-213 has a high level of need based on the overall Freight Index, SB directional PTI scores, closure duration in the NB direction	Y	No programmed project to address freight need
						L5	Pavement	Hot Spot SB at MP 195-199 and 200-201	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
87-4 (MP 213-235)	Hot Spot			High	High	L6	Safety	MP 213-235 high level of need relative to the Safety Index with little directional variation, motorcycle-related crashes Crash data analysis indicates percent of crashes above statewide average related to collision with fixed object and other non-collision crashes, 80% involve single vehicle, 53% speed to fast for conditions, and 80% run off road (left or right), and 80% single vehicle. 9 fatal crashes, 21 incapacitating injury, and 15 involving motorcycles.	Y	No programmed project to address safety need
						L7	Safety	Hot Spot NB at MP 213-215	Y	No programmed project to address safety need
						L8	Freight	MP 213-215 has a high level of need based on the overall Freight Index, NB directional Travel Time Index (TTI), and both directional PTI scores, closure duration in the NB direction	Y	No programmed project to address freight need

						L9	Pavement	Hot Spot NB/SB at MP 224-226	Y	No high historical investment in terms of projects that are strictly pavement rehabilitation projects, but per District input there have been numerous larger-scale projects associated with addressing landslide issues in the area that have included rehabilitating the pavement. District input indicates the area of repetitive pavement historical investment covers MP 224-231.
87-5 (MP 235-241)				Medium	High	L10	Freight	MP 235-241 has a high level of need based on the overall Freight Index, SB directional PTI scores	Y	No programmed project to address freight need
						L11	Safety	MP 235-241 SB Directional Safety Index high level of need	Y	No programmed project to address safety need
87-6 (MP 241-250)				High	High	L12	Freight	MP 241-250 has a high level of need based on the overall Freight Index, NB directional TTI, and both directional PTI scores, closure duration in the SB direction	Y	No programmed project to address freight need
						L13	Safety	MP 241-250 SB Directional Safety Index high level of need, and high rate of fatal and incapacitating injury crashes involving Strategic Highway Safety Plan (SHSP) Top 5 Emphasis Areas. Crash data analysis indicates percent of crashes above statewide average related to collision with fixed object, overturning, and other non-collision crashes, 86% involve single vehicle, 21% inattention, and 93% run off road (left or right) or crossed centerline, and 50% under the influence. 6 fatal crashes, 8 incapacitating injury crashes, and 2 involving motorcycles.	Y	No programmed project to address safety need
						L14	Safety	Hot Spot SB at MP 245-248	Y	No programmed project to address safety need
87-7 (MP 250-253)				N/A		No Strategic Needs Identified				
260-8 (MP 252-256)				Hot spot	High	L15	Freight	High level of need based on the overall Freight Index, EB directional PTI scores	Y	No programmed project to address freight need
						L16	Safety	Hot Spot EB at MP 252-253	Y	No programmed project to address safety need
260-9 (MP 256-260)			High	N/A	High	L17	Mobility	MP 256-260 has a poor Mobility Index performance score that reflects a high level of need for both existing and future Volume/Capacity (V/C) performance. This segment also exhibits poor performance in the EB directional PTI and poor Bicycle accommodation. This segment has a percentage of weather related closures greater than the statewide average	Y	No programmed project to address mobility need in first three years of five-year program, but reconstruction of segment to a 4-lane divided highway facility is programmed for design in FY 2021 with tentative construction in FY 2024
						L18	Freight	MP 256-260 has a high level of need based on the overall Freight Index, EB directional PTI scores, closure duration in the WB direction	Y	No programmed project to address freight need

260-10 (MP 260-277)					High	L19	Freight	MP 260-277 has a high level of need based on the overall Freight Index, both directional PTI scores, and closure duration in both directions	Y	No programmed project to address freight need
260-11 (MP 277-282)				N/A	High	L20	Freight	MP 277-282 has a high level of need based on the overall Freight Index, EB directional TTI and PTI scores, and closure duration in both directions	Y	No programmed project to address freight need
260-12 (MP 282-304)				High	High	L21	Safety	MP 282-304 EB Directional Safety Index high level of need with significant directional split	Y	No programmed project to address safety need
						L22	Freight	MP 282-304 has a medium level of need based on the overall Freight Index, WB directional PTI, and closure duration in the WB direction	Y	No programmed project to address freight need
260-13 (MP 304-306)	Medium			N/A	High	L23	Freight	MP 304-306 has a high level of need based on the overall Freight Index, WB directional TTI, both directional PTI scores, and closure duration in the WB direction	N	Closure need will be addressed by other strategic solutions. Other freight needs considered non-actionable. Data may not be reliable in this area because travel times likely skewed due to vehicles parking at businesses adjacent to the roadway.
						L24	Pavement	MP 304-306 has 50% pavement area failure	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
						L25	Pavement	Hot Spot EB at MP 304-305	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
277-14 (MP 306-313)	High			N/A	N/A	L26	Pavement	MP 306-313 has a High level of need relative to Pavement Index with over 71% pavement area failure	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
						L27	Pavement	Hot Spot NB at MP 307-310 and 311-313	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
377-15 (MP 0-34)				High	N/A	L28	Safety	MP 0-34 Safety Index high level of need both directions, and high rate of fatal and incapacitating injury crashes involving SHSP Top 5 Emphasis Areas. Crash data analysis indicates percent of crashes above statewide average including 73% for each overturning and involve single vehicle, 36% under the influence, 27% for each failure to keep in proper lane, and speed to fast for conditions, 64% ran off road (right), and 18% for sideswipe. 4 fatal crashes, 7 incapacitating injury crashes, and 3 involving trucks.	N	Programmed project in FY 2018 to reconstruct horizontal curves and widen shoulders to 8 feet in both directions (10 locations, MP 3-34).

77-16 (MP 386-389)	Medium		High	N/A	Medium	L29	Mobility	MP 386-389 has a high level of need driven by a poor future V/C and poor bicycle accommodation. The segment also has an at grade railroad crossing.	Y	No programmed project to address mobility need
						L30	Freight	MP 386-389 has a medium level of need based on the overall Freight Index	Y	No programmed project to address freight need
						L31	Pavement	MP 386-389 has a low level need based on the Pavement Index alone, but has 40% Pavement Area Failure	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
						L32	Pavement	Hot Spot NB at MP 388-389	N	No high historical investment so not considered a strategic investment; will likely be addressed by current ADOT processes.
40B-17 (MP 287-288)				N/A	High	L33	Freight	MP 287-288 has a high level of need based on the overall Freight Index and NB/SB directional TTI and PTI scores	N	Need will be partially addressed through the solutions developed for Segment 16. Remaining need considered non-actionable. Data may not be reliable in this area because travel times likely skewed due to vehicles parking at businesses adjacent to the roadway.

Legend: Strategic investment area screened out from further consideration

4.0 CANDIDATE SOLUTIONS

The corridor profile study identifies performance-based strategic solutions (investments) to help inform decision-making processes. This will enable ADOT to direct available funding resources to maximize the performance of the State's key transportation corridors. The corridor profile process is designed to mesh with the P2P Link and assigns strategic solutions to one of three categories for investment:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing strategic solutions for corridor preservation, modernization, and expansion. Strategic solutions are intended to complement ADOT's traditional project development processes through a performance-based analysis to identify needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic solutions developed for key corridors will be considered along with other candidate projects in the ADOT programming process.

4.1 Characteristics of Strategic Solutions

For the purposes of the corridor profile process, strategic solutions include the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (high or medium) and hot spots
- Focus on investments in Modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit (risk, life-cycle cost analysis, performance system, etc.)

4.2 Strategic Solution Types

Establishing uniform solution types enables the corridor profile process to compare proposed solutions on and across corridors to determine the effectiveness at improving performance, including cost and risk comparisons to be undertaken in subsequent tasks. **Appendix A** provides a list of the preliminary solutions currently proposed for corridor profile studies, separated into the three funding categories of Preservation, Modernization, or Expansion.

4.3 Candidate Solutions

The final step in this task is to identify candidate solutions that will be submitted for further analysis through the life-cycle cost and risk analysis tasks. The project team accessed a variety of resources to identify solutions to address strategic investment areas:

- Field reviews
- Observable trends from performance analysis
- Discussions with districts
- ADOT technical groups
- Review previous reports
- National best practices
- Professional judgment

Table 3 identifies each location that has been assigned a candidate solution with a number (e.g., CS87.1, 87.2, etc.). Each candidate solution is comprised of one or more components to address the identified needs. The assigned CS numbers are linked to the location numbers to provide tracking capability back to the screening process. The locations of proposed candidate solutions are shown in **Figure 5**.

In some cases, multiple solutions are proposed for a single location. Solutions that are proposed to address needs at the same location with alternative approaches (e.g., Option A, B, or C) are advanced to the Life-Cycle Cost evaluation in subsequent tasks to provide insights into the cost effectiveness of these options so a recommended solution can be identified. In locations where only one option has been developed, the next step is to advance that solution directly to the solution evaluation process for prioritization.

Solutions that are recommended to expand or modify the scope of an already programmed project are noted but are not advanced to solution evaluation and prioritization. These solutions will be directly recommended for programming.

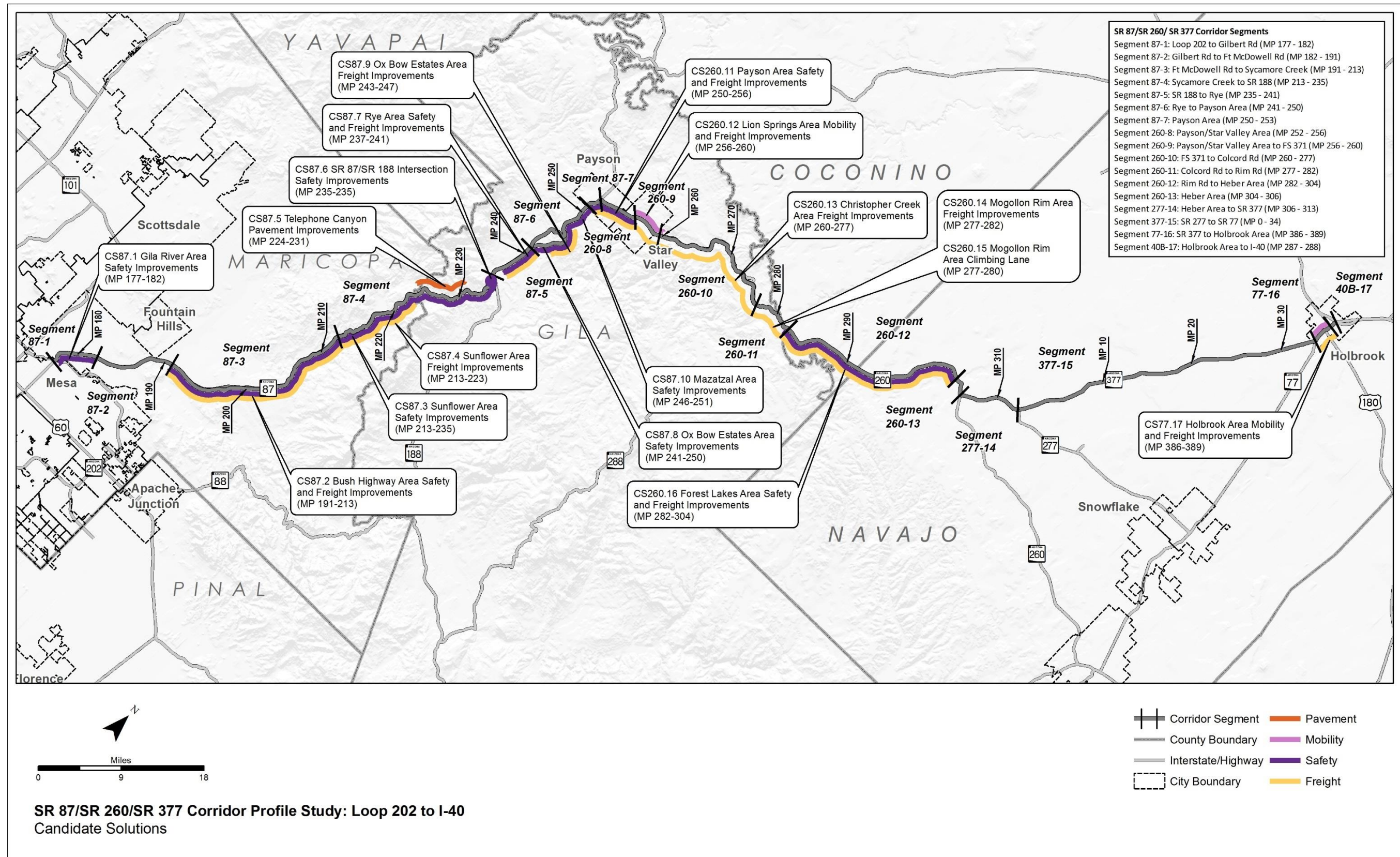
Table 3: Candidate Solutions

Candidate #	Location #	Name	Beginning Milepost	Ending Milepost	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS87.1	L1	Gila River Area Safety Improvements	177	182	-	-Install warning signs and chevrons on curved Gila River bridge approaches -Install raised pavement markers along the outside edge line -Install lighting at Oak St (MP 178.0), Center St (MP 179.1), Mesa Dr (MP 179.7), and Camelback Rd (MP 181.1) -Install raised concrete barrier in median on Gila River bridge and approaches (MP 177-177.5)	M
CS87.2	L3/L4	Bush Highway Area Safety and Freight Improvements	191	213	-	-Rehabilitate shoulders (NB/SB MP 194-205) -Install speed feedback signs (NB MP 206.5 and 207.7, NB/SB before curves and intersection with FR 68 [MP 209.6]) -Widen inside shoulders (SB MP 211-209)	M
CS87.3	L6/L7	Sunflower Area Safety Improvements	213	235	-	-Install speed feedback signs and speed advisory warning signs with flashing beacons at curves (NB MP 214.0, 217.8, 220.5, 224.5, 232.5; SB MP 231, 229.3, 221.0, 219.6, 216.0, 214.3) -Rehabilitate shoulders -Widen inside shoulders (SB MP 228.5-226.0) -Install rock-fall mitigation (NB MP 214.2-214.6; SB MP 228.9-228.7, 228.5-228.0, 217.6-218.0)	M
CS87.4	L8	Sunflower Area Freight Improvements	213	223	-	-Construct NB climbing lane, MP 213-215 and MP 219-223	M
CS87.5	L9	Telephone Canyon Pavement Improvements	224	231	A	-Rehabilitate pavement	P
					B	-Replace pavement	M
CS87.6	L11	SR 87/SR 188 Intersection Safety Improvements	235	235	-	-On SR 188 approaching SR 87 add flashing beacons to WB stop sign	M
CS87.7	L10/L11	Rye Area Safety and Freight Improvements	237	241	-	-Install advisory sign about approaching area with intersections (Deer Creek Drive [MP 237.6], Gisela Road [MP 239.5], two intersections in Rye [MP 240.5 and MP 240.8]) -Install reduced speed advisory sign on SR 87 (NB MP 240, SB MP 241) -Install speed feedback signs (NB MP 240, SB MP 241)	M
CS87.8	L13	Ox Bow Estates Area Safety Improvements	241	250	-	-Install speed feedback signs and speed advisory warning signs with flashing beacons at curves (SB MP 247, MP 245) -Implement variable speed limits MP 241-246 with new DMS and CCTV SB at MP 247 and new DMS and CCTV NB at MP 240 -Install RWIS at MP 245 with dynamic weather warning beacons	M
CS87.9	L12	Ox Bow Estates Area Freight Improvements	243	247	-	-Construct NB climbing lane	M
CS87.10	L14	Mazatzal Area Safety Improvements	246	251	-	-Widen shoulders SB MP 246.2-250.9	M
CS260.11	L15/L16	Payson Area Safety and Freight Improvements	250	256	-	-Implement signal coordination for five signals in Payson urban area (SR 87/SR 260 intersection, SR 260/Payson Village Center, SR 260/Manzanita Dr, SR 87/Main St, and SR 87/Bonita St) -Implement protected/permitted left-turn phasing at SR 87/Manzanita Dr intersection (NB and SB approaches) and provide advance signal advisory sign with flashing beacons WB on SR 87	M
CS260.12	L17/L18	Lion Springs Area Mobility and Freight Improvements	256	260	-	-Reconstruct to 4-lane divided highway	E

Candidate #	Location #	Name	Beginning Milepost	Ending Milepost	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS260.13	L19	Christopher Creek Area Freight Improvements	260	277	-	-Install rock-fall mitigation (WB MP 262.2-262.6, 261.9-261.6, 269.8-267.0; EB MP 269.9, 271.5, 272.7) -Implement variable speed limits at MP 272-277 and new DMS and CCTV at MP 272 EB	M
CS260.14	L20	Mogollon Rim Area Freight Improvements	277	282	-	-Install centerline rumble strips -Install rock-fall mitigation (WB MP 278.4-278.6, 279.8-280.9, 281.4-282) -Install RWIS at MP 282 with dynamic weather warning beacons -Implement variable speed limits at MP 277-282 and new DMS and CCTV at MP 282 WB	M
CS260.15	L20	Mogollon Rim Area Climbing Lane	277	280	-	-Construct EB climbing lane	M
CS260.16	L21/L22	Forest Lakes Area Safety and Freight Improvements	282	304	-	-Widen shoulders -Construct alternating passing lanes	M
CS77.17	L29/L30	Holbrook Area Mobility and Freight Improvements	386	389	A	-Construct new roadway connection between SR 377 and I-40/40B West TI (Exit 285) west of Holbrook. Includes new bridge over Little Colorado River and overpass at railroad crossing.	E
					B	-Construct new roadway connection between SR 77 and I-40/40B West TI (Exit 285) west of Holbrook. Includes new bridge over Little Colorado River and two overpasses over railroads	E
					C	-Construct overpass at at-grade railroad crossing along existing SR 77 alignment	E

* ‘ – ’ indicates only one solution is being proposed so there are no options for this solution

Figure 5: Candidate Solutions



4.4 Other Corridor Solutions

Besides the aforementioned candidate solutions, the SR 87/SR 260/SR 377 corridor was evaluated to determine if other corridor-specific solutions might be appropriate. These solutions would still be strategic but would involve corridor-specific programs or initiatives rather than location-based projects. The following corridor-specific solution was identified for the SR 87/SR 260/SR 377 corridor:

- Implement a driving impaired and speeding safety education campaign along the corridor
- Coordinate with the Arizona Game and Fish Department to conduct a study on vehicle/wildlife conflicts on SR 87 between MP 233 and MP 241

4.5 Policies and Initiatives

In addition to location-specific needs, general corridor and system-wide needs were also identified through the corridor profile process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them as well. Therefore, a recommended policies and initiatives list was developed for consideration when programming future projects not only on SR 87/SR 260/SR 377, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS.

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement

- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16 feet 3 inches where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent. Additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends given improvements and expansions to the state roadway network

5.0 NEXT STEPS

Candidate solutions identified in Working Paper 5 advance to be evaluated in multiple ways including a Life-Cycle Cost (where applicable), Risk Analysis, and a Performance Effectiveness Analysis. The methodology and approach to this analysis is briefly described below and will be documented in detail in Working Paper 6. **Figure 6** illustrates the candidate solution evaluation process.

Life-Cycle Cost Analysis – All pavement and bridge candidate solutions have multiple options: rehabilitate the area of need, or fully reconstruct the issue area or structure. These options will be evaluated through a life-cycle cost analysis (LCCA) to determine the best approach for each location where a pavement or bridge solution is recommended. The LCCA could eliminate options from further consideration and identify which options should be carried forward to further evaluation.

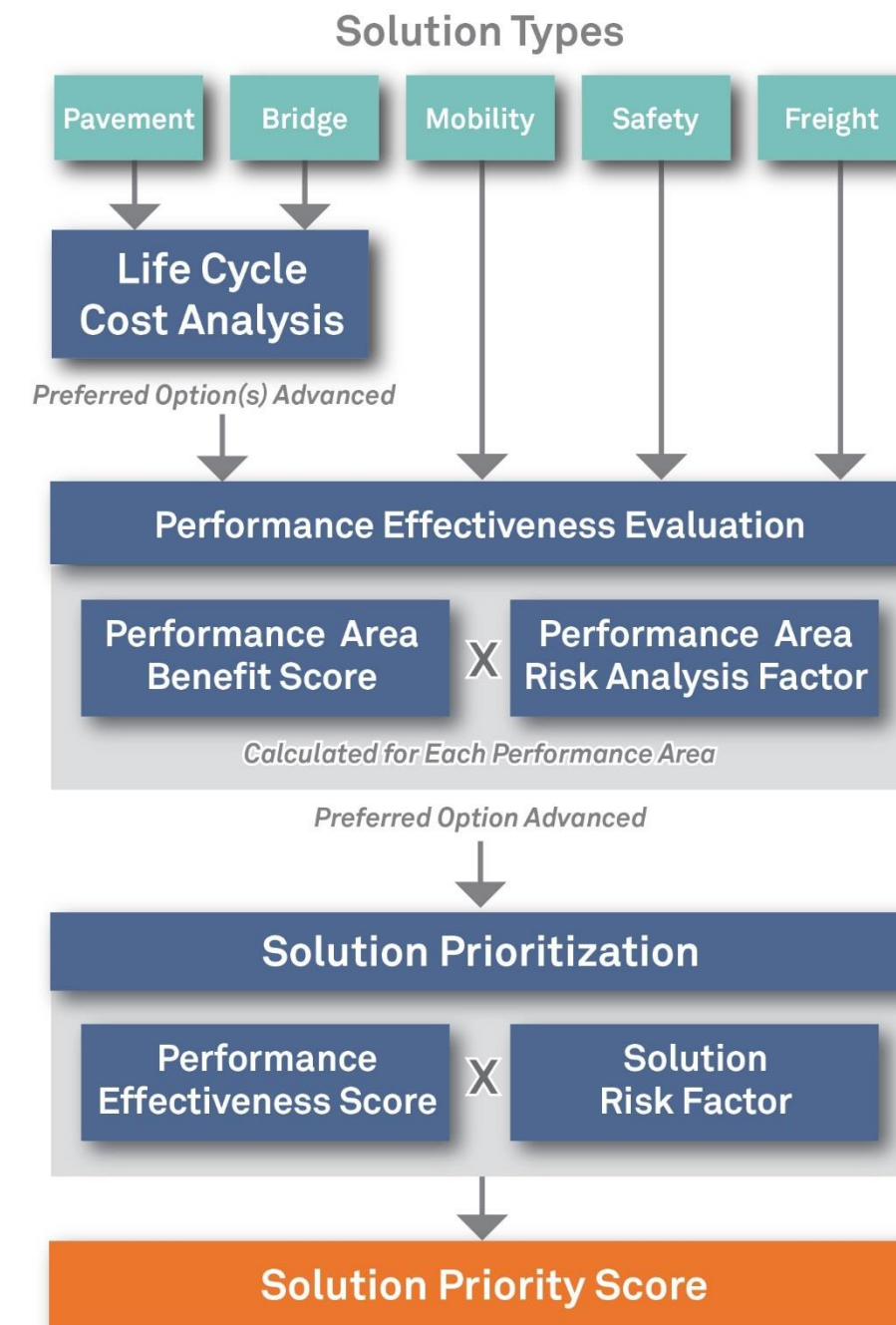
Performance Effectiveness Evaluation – After the LCCA process is complete, all remaining candidate solutions will be evaluated based on their performance effectiveness. This process will include determining a performance effectiveness score based on how much each solution impacts the existing performance and needs scores for each study segment. This evaluation will also include a Performance Area Risk Evaluation to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

Risk Analysis – All candidate solutions that are advanced through the Performance Effectiveness Evaluation will also be evaluated through a Risk Analysis process. This process will examine the risk of not implementing a recommended solution in terms of overall corridor performance. The results of this analysis will be combined with the Performance Effectiveness scores to determine the highest priority solutions in the corridor.

The highest ranking solutions will become recommended strategic investments for implementation and compared by ADOT to recommendations developed through other processes, such as the P2P Link process.

Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and consultants develop candidate projects for consideration in performance-based programming in the P2P Link process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for strategic corridors will be considered along with other candidate projects in the ADOT programming process.

Figure 6: Candidate Solution Evaluation Process



APPENDIX A: SOLUTION TYPES

PRESERVATION

REHABILITATION

- Rehabilitate Pavement
- Rehabilitate Bridge

MODERNIZATION

GEOMETRIC IMPROVEMENT

- Re-profile Roadway
- Realign Roadway
- Improve Skid Resistance

INFRASTRUCTURE IMPROVEMENT

- Reconstruct to Urban Section
- Construct Auxiliary Lanes
- Construct Climbing/Passing Lane
- Construct Reversible Lane
- Construct Entry/Exit Ramp
- Construct Turn Lanes
- Modify Entry/Exit Ramp
- Replace Pavement
- Replace Bridge
- Widen Bridge
- Install Pedestrian Bridge
- Implement Automated Bridge De-icing
- Install Wildlife Crossing
- Construct Drainage Structure
- Install Center Turn Lane

OPERATIONAL IMPROVEMENT

- Implement Variable Speed Limits
- Implement Ramp Metering
- Implement Shoulder Running
- Implement Signal Coordination/Adjust Timing
- Implement Left-turn Phasing

ROADSIDE DESIGN

- Install Guardrail
- Install Cable Barrier
- Widen Shoulder
- Rehabilitate Shoulder
- Replace Shoulder
- Install Rumble Strip
- Install Safety Edge
- Install Wildlife Fencing
- Remove Tree/Vegetation
- Install Centerline Rumble Strips
- Install Access Barrier Fence
- Install Rock-fall Mitigation
- Install Raised Concrete Barrier in Median

INTERSECTION IMPROVEMENT

- Construct Traffic Signal
- Improve Signal Visibility
- Install Raised Median
- Install Transverse Rumble Strips / Pavement Markings
- Construct Single-Lane Roundabout
- Construct Double-Lane Roundabout

ROADWAY DELINEATION

- Install High-Visibility Edge Line Striping
- Install High-Visibility Delineators
- Install Raised Pavement Markers
- Install In-Lane Route Markings

IMPROVED VISIBILITY

- Cut Side Slopes
- Install Lighting

DRIVER INFORMATION/WARNING

- Install Dynamic Message Sign (DMS)
- Install Dynamic Weather Warning Beacons
- Install Speed Feedback Signs
- Install Chevrons
- Install Warning Signs
- Install Wildlife Warning System
- Install Warning Signs with Beacons
- Install Larger Stop Sign with Beacons

DATA COLLECTION

- Install Road Weather Information System (RWIS)
- Install Closed Circuit Television (CCTV) Camera
- Install Vehicle Detection Stations
- Install Flood Sensors

EXPANSION

WIDEN CORRIDOR

- Construct New General Purpose Lane
- Convert a 2-lane Undivided Highway to a 5-lane Highway (4 Through Lanes with Continuous Two-way Left-turn Lane)
- Convert a 4-lane Undivided Highway to a 5-lane Highway (4 Through Lanes with Continuous Two-way Left-turn Lane)
- Construct 4-lane Divided Highway (Using Existing 2-lane Road for One Direction)
- Construct 4-lane Divided Highway (No Use of Existing Roads)
- Construct Bridge over At-grade Railroad Crossing
- Construct Underpass at At-grade Railroad Crossing
- Construct High-Occupancy Vehicle (HOV) Lane

ALTERNATE ROUTE

- Construct Frontage Roads
- Construct 2-lane Undivided Highway